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Sent: Wednesday, November 10, 1999 11:13 PM
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Subject: simple solution for extra range BT

Following the recent emphasis on the importance of an extended range BT solution, I would like to suggest again an idea that I have brought up long ago, and to receive your comments:
The selection of h=0.32 as the modulation index in Bluetooth is the result of the American regulations regarding the 20dB bandwidth of the modulated signal and the number of hopping channels (FCC part 15.247). In order for BT to be universal, the SIG had defined the phy layer to comply with the FCC rules, thus limiting the performance for users outside the USA as well. Since the standard was originally intended for short ranges (and was defined with a lousy sensitivity of –70dBm anyway), this didn't hurt too much.

Now if we can increase the modulation index to h=0.5 (MSK), thus achieving orthogonality, we can gain about 6dB in receiver performance.
Or even better, instead of orthogonality (Rho=0), we can use h=0.715 (Rho=-0.217), which is optimal FSK, and provides a 0.85dB gain over orthogonal FSK.

In the transmitter this requires holding different look-up-tables for the two types of modulating I&Q signals (standard with h=0.32, and enhanced with h=0.7).
In the receiver, a discriminator can be used for both (or a digital receiver). The optimal filtering is different for each.
The modulated signal exceeds the FCC's BW limits, but this is not really a problem when you consider:

1. BT devices used outside the USA (most of Nokia's phones?)
2. The FCC's proposed rule-making suggesting wider bandwidth (NPRM proceeding 99-231), which I have responded to.

This increase in modulation index h is equivalent to doubling the free-space range without changing anything in the RF sensitivity or transmission power.

Another range increase may be the result of a reduced set of hopping channels (e.g. 25 hopping channels instead of 79), enabling better interference avoidance through adaptive selection of channels. Again, this is a regulation issue in the USA, which has similar solutions (operation outside USA, and rule-making). Since the potential increase in range here is a result of better multipath/interference avoidance, it is dependent on the severity of those in a specific location. In certain cases it will offer no improvement at all, while in others, where an 802.11 system jams a third of the 2.4GHz band, for example, the increase in range will be significant.

In the two ideas above, both ends of the communication would have to be ours, and once this is determined by the devices, they can move from standard BT operation to Bluetooth Enhanced Technology (BET). I'm willing to BET on it myself.

Oren

Exhibit A